

Claims:

1. A system for generating a histogram of a plurality of power data values, the system comprising:

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a processing apparatus receiving the plurality of power data values and converting the plurality of power data values to a plurality of floating-point numbers; and

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a memory including a plurality of histogram bins connected electronically to the processing apparatus, wherein the processing apparatus stores counts of the plurality of floating-point numbers using each floating-point number as an address for a corresponding histogram bin in the memory.

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2. The system of claim 1, wherein the plurality of power data values comprise a plurality of $(I^2 + Q^2)$ data values.

3. The system of claim 2, wherein an exponent and a mantissa in the plurality of floating-point numbers are computed according to the equations:

$$\text{exponent} = 2^E - 1 - (\text{number of leading zeros in MS, up to } 2^E - 1)$$

$$\text{mantissa} = \text{MS}[(N - 2^{E-1} + \text{exp}) : (N - 2^E + \text{exp} - M)] \quad \text{for } \text{exp} > 0; \text{ or}$$

$$\text{mantissa} = \text{MS}[(N - 2^E) : (N - 2^{E+1} - M)] \quad \text{for } \text{exp} = 0$$

where E is the number of bits assigned to the exponent, M is the number of bits assigned to the mantissa, MS is a respective $(I^2 + Q^2)$ data value in the plurality of $(I^2 + Q^2)$ data values, and N is the number of bits assigned to the plurality of $(I^2 + Q^2)$ data values.

4. The system of claim 3, wherein the total number of histogram bins in the memory is determined by the equation $2^{(E+M)}$.

5. The system of claim 3, wherein a maximum bin width for the histogram bins is determined by the equation $10 * \log_{10}(1 + 2^{-M})$.

6. The system of claim 3, wherein a range of histogram bins is determined by the equation $(20 - 10 * 2^E) * \log_{10}(2)$.

7. The system of claim 1, wherein a maximum count for the histogram bins is determined by the equation $(2^w - 1)$, where w represents a bit width of the memory.

8. The system of claim 2, wherein the processing apparatus comprises:

a field programmable gate array receiving the plurality of $(I^2 + Q^2)$ data values; and

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a microprocessor connected electronically to the field programmable gate array, wherein the field programmable gate array and the microprocessor work cooperatively to convert each $(I^2 + Q^2)$ data value to a floating-point number and store counts of the plurality of floating-point numbers using each floating-point number as an address for a corresponding histogram bin in the memory.

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9. The system of claim 1, wherein the processing apparatus comprises:

an analog to digital converter receiving an analog immediate frequency signal and converting to a digital immediate frequency signal;

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an application specific integrated circuit receiving the digital immediate frequency signal, down-converting the immediate frequency signal to a baseband signal including a plurality of I and Q data values, and calculating the plurality of power data values comprised of a plurality of ($I^2 + Q^2$) data values;

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a field programmable gate array receiving the plurality of ($I^2 + Q^2$) data values; and

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a microprocessor connected electronically to the field programmable gate array, wherein the field programmable gate array and the microprocessor work cooperatively to convert each ($I^2 + Q^2$) data value to a floating-point number and store counts of the plurality of floating-point numbers using each floating-point number as an address for a corresponding histogram bin in the memory.

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10. The system of claim 1, wherein the processing apparatus comprises:

an analog to digital converter receiving an analog immediate frequency signal and converting to a digital immediate frequency signal; and

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an application specific integrated circuit receiving the digital immediate frequency signal, down-converting the immediate frequency signal to a baseband signal including a plurality of I and Q data values, calculating the plurality of power data values comprised of a plurality of ($I^2 + Q^2$) data values, converting each ($I^2 + Q^2$) data value to a floating-point number, and storing counts of the plurality of floating-point numbers using each floating-point number as an address for a corresponding histogram bin in the memory.

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11. The system of claim 2, wherein the processing apparatus comprises:

an analog to digital converter receiving a plurality of analog power data values and converting to a plurality of digital power data values comprised of ($I^2 + Q^2$) data values; and

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an application specific integrated circuit converting each ($I^2 + Q^2$) data value to a floating-point number and storing counts of the plurality of floating-point numbers using each floating-point number as an address for a corresponding histogram bin in the memory.

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12. A method for deriving a power complementary cumulative distribution function from a plurality of power data values, comprising:

a) receiving a power data value;

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b) converting the power data value to a floating-point number;

c) reading a location in a memory using the floating-point number as an address for the location in memory;

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d) incrementing by one a count read from the location in memory;

e) writing the incremented count to the location in memory; and

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f) repeating a through e until all of the power data values in the plurality of power data values have been received, converted, and accumulated in corresponding locations in memory; and

g) generating a histogram of the plurality of floating-point numbers

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using the memory locations as histogram bins.

13. The method of claim 12, further comprising calculating a complementary cumulative distribution function curve from the histogram.

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14. The method of claim 13, wherein calculating a complementary cumulative distribution function curve from the histogram comprises calculating an average power for the plurality of power data values according to the equation average power = $\sum (P_i * C_i) / \sum (C_i)$, for $i = 1$ to K , and K = number of bins, P_i is the power for the i th bin, and C_i is the count for the i th bin.

15. The method of claim 14, wherein calculating a complementary cumulative distribution function curve from the histogram comprises grouping the counts in the histogram bins into a plurality of CCDF bins.

16. The method of claim 15, further comprising:

performing linear interpolation on a count in a histogram bin when the count is divided between two CCDF bins.

17. The method of claim 12, wherein the plurality of power data values comprise a plurality of $(I^2 + Q^2)$ data values.

18. The method of claim 17, wherein converting the power data value to a floating-point number comprises computing an exponent and a mantissa for a floating-point number according to the equations:

$$\begin{aligned} \text{exponent} &= 2^E - 1 - (\text{number of leading zeros in MS, up to } 2^E - 1) \\ \text{mantissa} &= \text{MS}[(N - 2^E - 1 + \text{exp}) : (N - 2^E + \text{exp} - M)] \quad \text{for exp} > 0; \text{ or} \\ \text{mantissa} &= \text{MS}[(N - 2^E) : (N - 2^E + 1 - M)] \quad \text{for exp} = 0 \end{aligned}$$

where E is the number of bits assigned to the exponent, M is the number of bits assigned to the mantissa, MS is a respective ($I^2 + Q^2$) data value in the plurality of ($I^2 + Q^2$) data values, and N is the number of bits assigned to the power data value.

19. The method of claim 18, wherein the total number of histogram bins in the memory is determined by the equation $2^{(E+M)}$, a maximum bin width is determined by the equation $10 * \log_{10}(1 + 2^{-M})$, and a range of histogram bins is determined by the equation $(20 - 10 * 2^E) * \log_{10}(2)$.

20. The method of claim 12, wherein a maximum count each histogram bin in the memory can accumulate is determined by the equation $(2^w - 1)$, where w represents a bit width of the memory.